

MEMORANDUM FOR STUDENTS ENROLLED IN CHEN 3320 – Section 01

SUBJECT: CHEN 3320 Mass Transfer - Administrative Instructions

Lecture times:

MWF: 11:15 am – 12:10 pm

Instructor: Aaditya Khanal

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Welcome to CHEN 3320 – Mass Transfer. This course will introduce the basics of mass transfer processes, which are essential tools for the separation of components in mixtures for chemical processes. Mass transport by diffusion and convection will be covered, including their combination that results in a mass transfer coefficient. These concepts will be applied to the analysis of essential components of chemical processes, such as evaporators, cooling towers, flow through porous media, leaching, and extraction.

1. The course has three prerequisites which must be completed successfully prior to taking this course:

- ✓ CHEN 2320 (Chemical Engineering Mechanics)
- ✓ MATH 3305 (Differential Equations)
- ✓ CHEN 3302 (Chemical Engineering Thermodynamics II)

2. The goal of our faculty is to be commonly available to you for assistance, so you are encouraged and expected to seek **additional instruction (AI)**. Take advantage of AI, it's FREE and really will help! There are several ways you can seek AI:

- ✓ You are welcome to stop by the instructor's office at any time. However, for your own satisfaction, you can ensure the instructor is available at the office by using the following options:
- ✓ Come to Office hours (#). This is the time the instructor has set aside to answer your questions;
- ✓ E-mail or call the instructor to set up a mutually agreeable time to meet with the instructor,
- ✓ E-mail your questions to the instructor (this is the least preferred option because of the limited effectiveness of e-mail communication), but it is acceptable if other options are not possible.

3. Class Room Procedures:

- a. Bring study notes, **textbooks**, note-taking material, and calculator to every class. You may not borrow or exchange calculators during graded events. If your calculator fails during a graded exercise, I am not responsible to furnish a substitute. Class preparation is your individual responsibility.

b. *Textbooks:*

Welty, J.R.; Rorrer, G.; Foster, D.G.; “Fundamentals of Momentum, Heat, and Mass Transfer”, John Wiley & Sons, New York, 2014, 6th Edition (WRF).

Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. Dewitt, Fundamentals of Heat and Mass Transfer, 7thEd., John Wiley & Sons, 2011 (BLID).

Optional:

Transport Processes and Separation Process Principles”, 4th ed., Geankoplis, Prentice Hall, 2003. (G)

c. *Recitations:*

Certain lectures will be used for recitation sessions. These will be the students’ opportunity to practice problem-solving skills applying the concepts learned in lectures. These skills will be needed for solving homework, quizzes and exam problems. Please bring your textbook for the recitation sessions.

4. Evaluations:

- a. *ACADEMIC DISHONESTY:* Representation of other’s work as your own will not be tolerated. Cheating on examinations, quizzes, and homework and the false representation of work will be interpreted as academic dishonesty. Academic dishonesty will be subject to disciplinary action as outlined by the UT Tyler Student Guide on Conduct and Discipline.
- b. *Homeworks:* A set of homework problems will be assigned approximately every two weeks (there will be eight homework assignments during the semester). All homework is mandatory and becomes part of your grade. As an engineer your goal is to make a clear, logical, and professional presentation of your work, which is both accurate and correct. As such, both the presentation and the accuracy of your work is important, and both will be graded. It is critical that you show all of your work and leave “foot prints” so that it can be easily followed. No guess work should be required to see what you did. For each homework problem, the corresponding topic and numerical answers will be provided. You are encouraged to work in groups, but the work that you turn in should be your own. Homeworks are *due* at the beginning of class.
- c. *Open-ended projects:* At several points in the semester, students will be required to work on Open-Ended projects. Open-Ended projects are characterized for not having a unique, single answer/solution. Instead, they are creativity exercises in which you are encouraged to apply the concepts learned in the course. They may be qualitative or quantitative. In

either case, make sure your answer is clear and detailed, because you will be evaluated by the approach and thought process you use in these exercises. Open-Ended projects will be graded as follows:

2.0 pts – Solution is creative, complete, and makes excellent use of the concepts learned in class.

1.5 pts – Solution is complete or almost complete. It effectively applies the concepts learned in class, though it may contain one or more minor errors.

1.0 pt – Solution is partially complete. It attempts to apply concepts learned in class, but it contains one or more major errors.

0.5 pt – Presents an attempt to the Open-Ended project that is incomplete and does not properly apply the concepts learned in class.

0.0 pts – Solution is poor or suggests unethical/unprofessional actions.

You are encouraged to work in groups, but the work that you turn in should be your own. Turning in the same solution to the Open-Ended project as another student will be considered plagiarism.

- d. Late Submissions. It is a basic principle of professionalism that **“Professionals are not Late.”** A “COORDINATED LATE” submission occurs when you will miss the due date for a graded assignment and you contact me in advance. Notification immediately before the submission will not suffice. Point cuts up to the amounts below may be assessed for a “COORDINATED LATE” submission:

- | | |
|----------------------------|--|
| 1. 0-24 hours late | a deduction of 25% of the earned grade |
| 2. 24-48 hours late | a deduction of 50% of the earned grade |
| 3. More than 48 hours late | No credit. |

Obviously there are circumstances that will occur and make a timely submission impossible and I will work with you when and if they occur.

- 1) All homework and open-ended projects in this course must be properly documented. As you are having your work reviewed, it is likely that you might receive help from your classmates, just simply document it. Information from the course textbooks (equations and outlines of procedures), class notes, or me is considered immediately available to all students and need not be acknowledged or documented with one exception. **YOU ARE REQUIRED TO ACKNOWLEDGE AND DOCUMENT ALL OTHER ASSISTANCE AND REFERENCES USED.** Documentation will be accomplished in accordance with any manual for writing, footnote or endnote, for papers, but for written homework, just place the documentation right at the point you received help using “Who and what” assistance.

- e. *Quizzes*: There will be four quizzes on scheduled dates during the semester. *Quizzes will only include problems from previous homework assignments and/or recitations* (numerical values may be modified).

f. *Participation grade:* Students are expected to be engaged in class and outside of the class. The instructor will assign a participation grade to each student based on the following observations:

- 1) Attendance in class and punctuality;
- 2) Level of participation in class, asking questions about the material and answering questions from the instructor;
- 3) Engagement in recitation sessions, demonstrating initiative to work on problems, and actively participating in the discussions;
- 4) Asking questions outside class: after class, during office hours, and by e-mail.

Attendance in class is the component with more weight on participation. A student that attends every class, but otherwise is not active will receive a 3.0/6.0 as participation grade.

g. *Mid-Term Exams and Final Exam:*

There will be one Midterm Exam and one Final exam. The Midterm will be fifty-five minutes long, and the Final will be two hours long. The dates for Exams are included in the course schedule. Official reasons for missing an exam are outlined in the “Student Handbook”. You are required to take a make-up Exam, regardless of your reason for missing the scheduled Exam. Report any conflict to me as soon as possible prior to the Exam. You can use a **TI-30 calculator** (or FE equivalent), and *an equation sheet will be provided by the instructor.*

5. Grading:

Grades will be based entirely on the student’s demonstrated ability to develop detailed, neat, organized, and correct solutions to the problems presented. Correct answers accompanied by incorrect, incomplete, or untidy solutions may receive no credit.

Course Points

Quizzes (4 at 5.0 points each)	20 (20 %)
Homeworks (8 at 2.0 points each)	16 (16 %)
Open-ended projects (4 at 4.0 points each)	16 (16 %)
Participation (1 at 8.0 points)	8 (8 %)
Midterm Exam (1 at 20 points)	20 (20%)
Final Examination (1 at 20 points)	20 (20%)
Total	100 (100%)

Grade Scale based on points

1.15 x class average or higher	A
Between class average and 1.15x time class average	B
Between 50 points and the class average	C
Between 30 and 50 points	D
Less than 30 points	F

You need at least 50 points total to pass the course with a C grade. You need to be at the class average to receive a B grade.

6. Collection of Student Work:

Throughout the semester I will collect student work (best, average, and worst) for the ABET course and outcomes notebooks. This will require me to make a copy of your work, keep your original and return a copy of the graded work to you. I will not draw attention as to what level of work you accomplished.

7. Assigned readings:

The class schedule will include assigned reading for every lecture. Students who read the corresponding sections of the book *before each class* will certainly make the most of the lectures, so this is highly recommended. In addition, the instructor will periodically post the lecture notes on the course website. Doing the assigned reading prior to class will help you to understand the material presented during the instruction and will fill in gaps for things we do not cover (***I will not cover everything***). It will also make you more familiar with terms and concepts to be covered.

8. **UT Tyler Honor Code** - Every member of the UT Tyler community joins together to embrace: Honor and integrity that will not allow me to lie, cheat, or steal, nor to accept the actions of those who do.

9. **Students Rights and Responsibilities:** to know and understand the policies that affect your rights and responsibilities as a student at UT Tyler, please follow this link: <http://www.uttyler.edu/wellness/rightsresponsibilities.php>.

10. **Campus Carry** - We respect the right and privacy of students 21 and over who are duly licensed to carry concealed weapons in this class. License holders are expected to behave responsibly and keep a handgun secure and concealed. More information is available at <http://www.uttyler.edu/about/campus-carry/index.php>.

11. **UT Tyler a Tobacco-Free University** - All forms of tobacco will not be permitted on the UT Tyler main campus, branch campuses, and any property owned by UT Tyler. This applies to all members of the University community, including students, faculty, staff, University affiliates, contractors, and visitors. Forms of tobacco not permitted include cigarettes, cigars, pipes, water pipes (hookah), bidis, kreteks, electronic cigarettes, smokeless tobacco, snuff, chewing tobacco, and all other tobacco products. There are several cessation programs available to students looking to quit smoking, including counseling, quitlines, and group support. For more information on cessation programs please visit www.uttyler.edu/tobacco-free.

12. **Grade Replacement/Forgiveness and Census Date Policies** - Students repeating a course for grade forgiveness (grade replacement) must file a Grade Replacement Contract with the Enrollment Services Center (ADM 230) on or before the Census Date of the semester in which the course will be repeated. Grade Replacement Contracts are available in the Enrollment

Services Center or at <http://www.uttyler.edu/registrar>. Each semester's Census Date can be found on the Contract itself, on the Academic Calendar, or in the information pamphlets published each semester by the Office of the Registrar. Failure to file a Grade Replacement Contract will result in both the original and repeated grade being used to calculate your overall grade point average. Undergraduates are eligible to exercise grade replacement for only three course repeats during their career at UT Tyler; graduates are eligible for two grade replacements. Full policy details are printed on each Grade Replacement Contract. The Census Date is the deadline for many forms and enrollment actions of which students need to be aware. These include:

- Submitting Grade Replacement Contracts, Transient Forms, requests to withhold directory information, approvals for taking courses as Audit, Pass/Fail or Credit/No Credit.
- Receiving 100% refunds for partial withdrawals. (There is no refund for these after the Census Date)
- Schedule adjustments (section changes, adding a new class, dropping without a "W" grade)
- Being reinstated or re-enrolled in classes after being dropped for non-payment
- Completing the process for tuition exemptions or waivers through Financial Aid

13. State-Mandated Course Drop Policy - Texas law prohibits a student who began college for the first time in Fall 2007 or thereafter from dropping more than six courses during their entire undergraduate career. This includes courses dropped at another 2-year or 4-year Texas public college or university. For purposes of this rule, a dropped course is any course that is dropped after the census date (See Academic Calendar for the specific date). Exceptions to the 6-drop rule may be found in the catalog. Petitions for exemptions must be submitted to the Enrollment Services Center and must be accompanied by documentation of the extenuating circumstance. Please contact the Enrollment Services Center if you have any questions.

14. Disability/Accessibility Services - In accordance with Section 504 of the Rehabilitation Act, Americans with Disabilities Act (ADA) and the ADA Amendments Act (ADAAA) the University of Texas at Tyler offers accommodations to students with learning, physical and/or psychological disabilities. If you have a disability, including a non-visible diagnosis such as a learning disorder, chronic illness, TBI, PTSD, ADHD, or you have a history of modifications or accommodations in a previous educational environment, you are encouraged to visit <https://hood.accessiblelearning.com/UTTyler> and fill out the New Student application. The Student Accessibility and Resources (SAR) office will contact you when your application has been submitted and an appointment with Cynthia Lowery, Assistant Director of Student Services/ADA Coordinator. For more information, including filling out an application for services, please visit the SAR webpage at <http://www.uttyler.edu/disabilityservices>, the SAR office located in the University Center, # 3150 or call 903.566.7079.

15. Student Absence due to Religious Observance - Students who anticipate being absent from class due to a religious observance are requested to inform the instructor of such absences by the second class meeting of the semester.

16. Student Absence for University-Sponsored Events and Activities - Revised 05/19 If you intend to be absent for a university-sponsored event or activity, you (or the event sponsor) must

notify the instructor at least two weeks prior to the date of the planned absence. At that time the instructor will set a date and time when make-up assignments will be completed.

17. Social Security and FERPA Statement - It is the policy of The University of Texas at Tyler to protect the confidential nature of social security numbers. The University has changed its computer programming so that all students have an identification number. The electronic transmission of grades (e.g., via e-mail) risks violation of the Family Educational Rights and Privacy Act; grades will not be transmitted electronically.

18. Emergency Exits and Evacuation - Everyone is required to exit the building when a fire alarm goes off. Follow your instructor's directions regarding the appropriate exit. If you require assistance during an evacuation, inform your instructor in the first week of class. Do not re-enter the building unless given permission by University Police, Fire department, or Fire Prevention Services.

19. Student Standards of Academic Conduct - Disciplinary proceedings may be initiated against any student who engages in scholastic dishonesty, including, but not limited to, cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts.

i. "Cheating" includes, but is not limited to:

- copying from another student's test paper;
- using, during a test, materials not authorized by the person giving the test;
- failure to comply with instructions given by the person administering the test;
- possession during a test of materials which are not authorized by the person giving the test, such as class notes or specifically designed "crib notes". The presence of textbooks constitutes a violation if they have been specifically prohibited by the person administering the test;
- using, buying, stealing, transporting, or soliciting in whole or part the contents of an unadministered test, test key, homework solution, or computer program;
- collaborating with or seeking aid from another student during a test or other assignment without authority;
- discussing the contents of an examination with another student who will take the examination;
- divulging the contents of an examination, for the purpose of preserving questions for use by another, when the instructors has designated that the examination is not to be removed from the examination room or not to be returned or to be kept by the student;
- substituting for another person, or permitting another person to substitute for oneself to take a course, a test, or any course-related assignment;
- paying or offering money or other valuable thing to, or coercing another person to obtain an unadministered test, test key, homework solution, or computer program or information about an unadministered test, test key, home solution or computer program;
- falsifying research data, laboratory reports, and/or other academic work offered for credit;
- taking, keeping, misplacing, or damaging the property of The University of Texas at Tyler, or of another, if the student knows or reasonably should know that an unfair academic advantage would be gained by such conduct; and

- misrepresenting facts, including providing false grades or resumes, for the purpose of obtaining an academic or financial benefit or injuring another student academically or financially.

ii. “Plagiarism” includes, but is not limited to, the appropriation, buying, receiving as a gift, or obtaining by any means another’s work and the submission of it as one’s own academic work offered for credit.

iii. “Collusion” includes, but is not limited to, the unauthorized collaboration with another person in preparing academic assignments offered for credit or collaboration with another person to commit a violation of any section of the rules on scholastic dishonesty.

iv. All written work that is submitted will be subject to review by plagiarism software.

20. UT Tyler Resources for Students

- UT Tyler Writing Center (903.565.5995), writingcenter@uttyler.edu
- UT Tyler Tutoring Center (903.565.5964), tutoring@uttyler.edu
- The Mathematics Learning Center, RBN 4021, this is the open access computer lab for math students, with tutors on duty to assist students who are enrolled in early-career courses.
- UT Tyler Counseling Center (903.566.7254)

CHEN 3320 Mass Transfer Course Objectives:

1. Discuss the concepts of Molecular diffusion, diffusivity and mass fluxes
2. Apply Fick’s law and material balances for the analysis of mass transfer processes
3. Use the differential species balance to solve steady and transient problems
4. Discuss the concept of convective mass transfer and mass transfer boundary layer
5. Apply literature correlations to estimate mass transfer coefficients
6. Analyze mass transfer between phases
7. Apply mass transfer concepts to analyze process equipment

Schedule:

week		January	Material	Assigned Reading	Evaluation due
1	M	13	Syllabus, Intro to mass transfer, Molecular diffusion and Ficks’Law	M.S. pp. 527-532 G, pp. 3-5, 410-414	-
	W	15	Molecular diffusion in gases, JA vs. NA	M.S. pp. 533-535, G. pp. 414-422	-
	F	17	Molecular Diffusion with convection	M.S. pp. 533-535, G. pp. 428-429	-

2	M	20	Analysis of special cases: Stagnant film diffusion, Equimolar counter diffusion	M.S. pp. 533-535, G. pp. 428-429	-
	W	22	Prediction of diffusivities	MS. p. 535-539, G. pp. 422-435	-
	F	24	Differential Equations in Mass Transfer	BLID., p. 934-954, WRF 467 - 472	HW 1
3	M	27	Boundary Conditions and Discontinuous Concentrations	BLID., 954 – 960, WRF 472 - 475	-
	W	29	Steady-state Molecular diffusion	WRF 452 - 458	-
	F				-
		February	Material	Assigned Reading	Evaluation due
4	M		Pseudo-steady state diffusion	WRF 458 - 461	-
	W		One dimensional systems with Chemical Reaction	WRF 463 - 469	-
	F		-	-	HW 2, Quiz 1
5	M		Diffusion with a homogeneous first order reaction	WRF 469 - 474	-
	W		Two and three dimensional systems	WRF 474 - 478	-
	F		Simultaneous heat and transfer	WRF 479 - 483	-
6	M		Simultaneous momentum and mass transfer	WRF 483 - 488	-
	W		Transient molecular diffusion in a semi-infinite medium	WRF 496 - 500	-
	F		Transient diffusion in a finite-dimensional medium	WRF 500 - 508	HW 3
7	M		Concentration-time charts	WRF 509 - 512	-
	W		Convective Mass Transfer, parameters	WRF 517 - 521	-
	F		Dimensional Analysis	WRF 521 - 523	-
		March	Material	Assigned Reading	Evaluation due
8	M		Laminar Concentration Boundary Layer – Exact Analysis	WRF 524 - 531	-
	W		Laminar Concentration Boundary Layer – Approximate Analysis	WRF 531 - 533	-

	F		-	--	HW 4, Quiz 2
9	M		Mass, Energy, and momentum Transfer Analogies	WRF 533 - 542	-
	W		Mass, Energy, and momentum Transfer Analogies, cont.	WRF 533 - 542	-
	F	-	-	-	Midterm Exam
-	M	-	No class -spring break	-	-
	W	-	No class -spring break	-	-
	F	-	No class -spring break	-	-
10	M		Correlations for Convective Mass Transfer	BLID. 434 - 446, 452 - 454 , WRF 569 - 595	-
	W		Correlations for Convective Mass Transfer	BLID. 434 - 446, 452 - 454 , WRF 569 - 595	-
	F		Correlations for Convective Mass Transfer	BLID. 434 - 446, 452 - 454 , WRF 569 - 595	-
11	M		Convective Mass Transfer Between Phases, Equilibrium	WRF 551-554	-
		April	Material	Assigned Reading	Evaluation due
11	W		The Two-resistance theory	WRF 554 - 557	HW 5
	F		Overall mass transfer coefficients	WRF 554 - 557	
12	M		Overall mass transfer coefficients, ctd.	WRF 554 - 557	-
	W		Mass transfer equipment - types	WRF 603 - 605	-
	F		-	-	HW 6, Quiz 3
13	M		Gas-liquid mass transfer in well mixed tanks	WRF 605 - 610	-
	W		Mass transfer in towers	WRF 611 - 620	-
	F		Mass transfer in towers	WRF 611 - 620	-
14	M		Enthalpy balances for towers	WRF 620 - 621	-
	W		Mass transfer capacity coefficients	WRF 621 - 622	-
	F		-	-	HW 7, Quiz 4
15	M		-	-	-
	W		-	-	Final Exam

Final Exam: TBA